**An Information Report by the
TMDD Steering Committee of**

ITE and AASHTO

Version 1.0

TMDD & MS/ETMCC Guide

*Standard for Functional Level
Traffic Management Data Dictionary (TMDD) and Message Sets
for External Traffic Management Center Communications*

October 30, 2000

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ABSTRACT

Motivations Behind the Standards: Many of the initial efforts at deploying Intelligent Transportation Systems have traditionally used unique or proprietary definitions of transportation data to build specific applications to meet their immediate implementation needs. However, data described in such unique or proprietary ways, and messages between systems constructed using non-standardized data have in the past resulted in the following undesirable situations:

- Complicated system expansion with inclusion of desirable new features and functions,
- Restricted ability for different components and subsystems within an implementation to work together or to readily accept upgrades due to a "closed architecture", and
- Lessened ability to share data and/or exchange information among organizations and/or jurisdictions.

Addressing this lack of "interoperability" has been one of the driving motivations for establishing standards such as those discussed in this Guide.

Why the Standards are Needed: The Traffic Management Data Dictionary and Message Sets for External Traffic Management Center Communications Standards work together to provide a high level of interoperability among regional and local systems/centers. These Standards will:

- Help traffic agencies and emergency management agencies to more easily and clearly communicate during incident conditions, working to improve safety,
- Improve the potential of having effective traveler information systems with data and information that travelers want to know, and
- Enable public agencies and private companies to reduce system deployment costs and project delays while providing more effective public service and customer benefits.

What are the Standards and How They Work: The Traffic Management Data Dictionary Standard provides consistent names, definitions, and concepts similar to spelling and parts of speech to the word-like "data elements" in the Standard. The Traffic Management Data Dictionary enables concepts from traffic management to be defined and used in the same way by different systems and centers. However, the Standard also anticipates and provides for the use of locally unique data elements to recognize the individuality of each system or center. The Message Sets for External Traffic Management Center Communications Standard uses these data elements by combining them together in a sentence-like way in the sharing of data or pre-defined typical messages between systems or centers. That Standard also anticipates that every center will have their own unique messages they want to send and receive.

Relationship to other Standards Efforts and Lessons Learned: These two Standards provide a framework for interoperability that is consistent with the National ITS Architecture and work in conjunction with other standards, such as the Standard for Data Dictionaries. There are also complementary standards for other functional areas associated with Intelligent Transportation Systems, such as a similar data dictionary for Traveler Information Systems. There is a need to have a clear plan for migrating from current systems to those that are being planned, designed, and implemented to be in conformance with these two Standards.

CONTENTS

1 Foreword 7
1.1 Purpose of the TMDD & MS/ETMCC Guide 7
1.2 Organization of this TMDD & MS/ETMCC Guide 8
1.3 Disclaimers 10
1.4 Additional Information 10

2 Overview of the TMDD and MS/ETMCC Standards 11
2.1 Introduction 11
2.2 What are the Functional Level TMDD & MS/ETMCC Standards? 14
2.3 Why Do We Need the TMDD & MS/ETMCC Standards? 14
2.4 How will the Standards be Used in Overall System Implementaion? 16
2.5 When are Standard Data Dictionaries and Message Sets Useful? 16
2.6 Who are the Expected Typical Users of the TMDD & MS/ETMCC Standards? 17
2.7 What Lessons have been Learned? 18
2.8 Where to go for Further Information or Training on these and Other Standards? 18

3 Understanding the TMDD & MS/ETMCC Standards 19
3.1 Introduction 19
3.2 Analogies to Parts of Speech 19
3.3 Scope of Data and Message Exchanges Supported by the Standards 23
3.4 Structure and Interrelationships within the Standards Framework 24
3.5 Issues and Challenges to be Addressed in Planning to Use the Standards 26
3.6 Relationship to the National ITS Architecture and other Standards 29
3.7 Benefits of Using the TMDD & MS/ETMCC Standards 33

4 Specifying Traffic Management System Improvements Using the TMDD Standard 35
4.1 Introduction 35
4.2 Translating Systems Needs and Requirements to Specifications 35
4.3 Specific Structure and an Example of the Data Element Formats 36
4.4 Meta-data Attributes of Individual Data Elements 37
4.5 Adapting the Functional-Area Data Dictionary to an Application-Specific Data Dictionary 38
4.6 Additional Guidance for Specification Writers 39

5 Designing with the TMDD standard 40
5.1 Introduction 40
5.2 Creating an Application-Specific Data Dictionary using the TMDD 40
5.3 Seeking Conformance Between Application-Specific Data Dictionaries and the TMDD 41
5.4 Providing Migration Alternatives for Transition Between Legacy Systems and an Application-Specific Data Dictionary 42
5.5 Accounting for Unique Application-Specific Data Elements 43
5.6 Recognition of Spatial Interdependencies Among Parts of the System 43
5.7 Maintaining Consistency with the National ITS Architecture 44
5.8 Opportunities for Feedback to the TMDD Standard Process 45

6 Implemention and Operations using the TMDD Standard 46
6.1 Introduction 46
6.2 Implementing Systems in Accordance with Specifications and Designs 46
6.3 Applying the TMDD Standard to Day-to-Day Operations 47
6.4 Maintaining the On-going Effectiveness of the Application-Specific Data Dictionary 49
6.5 Lessons Learned from Initial Deployments 50

6.6 Accounting for Subsequent Revisions to the TMDD Standards 52
6.7 Expectation of Future Changes in Associated Standards 53

7 Specifying Traffic Management System Improvements Using the MS/ETMCC Standard 54
7.1 Introduction 54
7.2 Translating Systems Needs and Requirements to Specifications 54
7.3 Specific Structure of the Messages and Message Set Formats 55
7.4 Meta-data Attributes of Individual Messages and Message Sets 57
7.5 Adapting the MS/ETMCC Standard to a Specific Application 58
7.6 Additional Guidance for Specification Writers 58

8 Designing with the MS/ETMCC standard 59
8.1 Introduction 59
8.2 Creating Application-Specific Messages using the MS/ETMCC Standard 59
8.3 Seeking Conformance Between Application-Specific Messages using the MS/ETMCC Standard 59
8.4 Providing Migration Alternatives for Transition Between Legacy Systems and Message Sets 60
8.5 Accounting for Unique Application-Specific Message Sets 61
8.6 Maintaining Consistency with the National ITS Architecture 61
8.7 Opportunities for Feedback to the MS/ETMCC Standard Process 62

9 Implemention and Operations Using The MS/ETMCC Standard 63
9.1 Introduction 63
9.2 Implementing Systems in Accordance with Specifications and Designs 63
9.3 Applying the MS/ETMCC Standard in Day-to-Day Operations 64
9.4 Maintaining the On-going Effectiveness of the Messages and Message Sets 65
9.5 Lessons Learned from Initial Deployments 66
9.6 Accounting for Subsequent Revisions to the MS/ETMCC Standard 68
9.7 Expectation of Future Changes in Associated Standards 69

10 Glossary and Definitions 70
10.1 Abbreviations and Acronyms 70
10.2 Definitions 72

11 Bibliography 77
11.1 Selected Reading List and References 77

12 Process for Requesting Updates and Revisions 79
12.1 Purpose and Options 79
12.2 Recommended Approach 80

13 Example TMDD and MS/ETMCC Implementations 82
13.1 Transcom Regional Architecture 83
13.2 North Seattle Advanced Transportation Management System 85
13.3 CHART's Dynamic Message Signs 86
13.4 Dallas/Fort Worth Area Deployment Using the National ITS Architecture 88

TMDD & MS/ETMCC Guide

1 FOREWORD

The Standards for Functional Level (Advanced) Traffic Management (System) Data Dictionary (TMDD) and for Message Sets for External Traffic Management Center Communication (MS/ETMCC) are receiving increasing attention as agencies seek to deploy elements of the National Intelligent Transportation System (ITS) Architecture. For ease of communication, this Guide refers to them separately as the TMDD Standard or MS/ETMCC Standard, and together as the TMDD & MS/ETMCC Standards or the "Traffic Management Information Standards".

The transportation community has long needed an ability to effectively, efficiently, and unambiguously exchange information electronically among:

- Traffic Management Centers (TMCs),
- Emergency Services Agencies and Centers,
- Information Service Providers and the traveling public, and
- Other transportation service providers such as transit agencies or airports

This transportation community consists of public agencies, private companies, and travelers each having general roles. Traffic Management Centers and systems are usually owned and operated by public sector agencies. Organizations that supply hardware, software, and/or system integration services to such centers and systems, as well as many users of information from them, are most often private sector companies. Individual travelers, business, and governmental agencies own the private vehicles and vehicle fleets that use the publicly owned and operated transportation facilities.

It is expected that the Traffic Management Information Standards will be widely embraced and specified in the deployment of new and upgraded ITS deployments. That will directly facilitate exchanges of data and information among these many involved and diverse public and private sector organizations and indirectly with individual travelers and shippers.

1.1 Purpose of the TMDD & MS/ETMCC Guide

The prime purpose of this Guide is to assist decision makers and practitioners to generally understand the nature, role, and benefits of using the Traffic Management Information Standards. To do that the Guide has the following five specific purposes:

- Provide a general awareness to decision makers and managers about the TMDD & MS/ETMCC Standards and serve as a basis for technology transfer and training,
- Improve understanding to support better resource allocation decision-making,
- Help identify requirements for new systems,

- Give a context to system design, and
- Develop insight for system implementation and operation.

This Guide provides general information and a context to the use of the TMMD & MS/ETMCC Standards. It is not a "how to" guide, or "users manual" style guide. These five specific purposes are reflected in the organization of the Guide, as discussed in the next subsection.

1.2 Organization of this TMDD & MS/ETMCC Guide

This Guide is being addressed to several audiences at the same time, where each audience is presumed to have a somewhat different set of interests and underlying knowledge base. However, it is recognized that the interests and knowledge base of any individual reader may differ from that of any one of the presumed audiences. Thus, while the Guide is organized and oriented primarily according to the intended audiences, there is also the expectation that each reader will delve into each Section of the Guide for their individual purposes. At different times, an individual reader may be more interested in one section of this Guide than another. The orientation of each Section named below is as follows:

Abstract; Foreword; and Overview of the TMDD & MS/ETMCC Standards: Each of these Sections are intended principally for decision makers and managers such as a City Traffic Engineer or a Traffic Operations Engineer in charge of a regional or district office of a State transportation department as well as the staff that serve them. In particular, the Abstract for Decision Makers and Managers and the Overview to the TMDD & MS/ETMCC Standards Sections provide a quick synopsis of the Standards, motivations behind their use, the need for the Standards, as well as some of their key features. They also include a discussion of the relationship to other standards. Those sections also tend to have a broader, more statewide or regional emphasis.

Understanding the TMDD & MS/ETMCC Standards: Section 3 of the Guide is intended principally for traffic and transportation engineers, transportation planners, and TMC managers. In addition, it will help decision makers and other managers better appreciate the importance of the Standards being used as well as some challenges that may be faced by their staff in deploying systems using them. This Section gives a general overview of the issues associated with using the TMDD & MS/ETMCC Standards in various applications. It also is a good starting point for anyone wishing to become better informed on the various concepts and technical aspects associated with using and applying a data dictionary. This section tends to have a regional or more local emphasis.

Specifying Traffic Management System Improvements: Sections 4 and 7 are intended for writers specifying desired improvements to Traffic Management Systems or Centers using the TMDD Standard and the MS/ETMCC Standard, as well as for software system integrators and maintainers of the systems and centers. In many instances the public agencies needing to use the Standards are contracting out for professional System Engineering services to design and implement applications that rely upon the Standards.

Those two Sections are also intended to help agency or contractor project managers who will be setting directions and/or reviewing activities in developing the architecture for a given system.

The TMDD Standards consist of many data elements organized according to several Annexes. It is important that specification writers have a good grasp of the ways that the Annexes and Data Elements interrelate and would be appropriate for particular applications. Satisfying the user agency specifications in a TMDD deployment requires:

- Careful analysis and articulation of the agency's requirements,
- Careful mapping of the various TMDD & MS/ETMCC options to those requirements, and
- Specifications for services that are written with appropriate understanding of the Standards.

Designing with the TMDD & MS/ETMCC Standards: Sections 5 and 8 are intended for those designing the communications and data exchange elements of transportation systems. Those Sections include discussion on the relationship between the TMDD & MS/ETMCC Standards and application-specific data dictionaries, as well as the need for conformance between them. Those Sections also recognize that design may need to provide for migration alternatives to transition from various legacy systems to systems that are in full conformance. Relationships to the National ITS Architecture also need to be accounted for and considered.

Implementing and Operating with the TMDD & MS/ETMCC Standards: Sections 6 and 9 are intended principally for the various systems implementers and software system maintainers who will rely on the TMDD Standard and the MS/ETMCC Standard. Included are software maintainers who are expected to keep the systems running and work with modifications and updates. Since the TMDD Steering Committee guiding the preparation of this Guide consisted of many individuals involved in actual deployments of the new Standards, these sections are meant to provide the necessary insight often required to achieve successful deployment and operations. In particular, some of the lessons learned and common pitfalls encountered during actual deployments will be discussed, with suggested solutions. A process to update and revise the Standards will also be referenced.

The remainder of the Guide provides ancillary information in the following Sections:

(10) A glossary with a listing of nearly 100 terms, abbreviations, acronyms, and definitions that readers should refer to when they are not sure of the meaning of a word, abbreviation, or acronym used in the Guide,

(11) A bibliography of selected readings,

(12) The process for requesting an update or revision to the Standards,

(13) Selected examples of TMDD & MS/ETMCC Standards implementations, and

1.3 Disclaimers

These Standards will continue to evolve. The Steering Committee has provided a process for updates and revisions, given in Section 12 of this Guide. Thus, in implementing systems, users of the Standards need to be aware of possible changes that may have occurred since publication of the version of the Standards they are using. The Steering Committee anticipates that there would be changes to the Standards, especially during the first few years of implementation.

1.4 Additional Information

For more information about the TMDD & MS/ETMCC Standards, visit the TMDD Web Site at http://www.ite.org.tmdd. In order to obtain a printed summary of TMDD information, contact the TMDD Coordinator at the following address (starting in December 2000).

Standards Coordinator
Institute of Transportation Engineers
1099 14th Street, N.W.
Washington, D.C. 20005-3438

In preparation of the Functional Level TMDD & MS/ETMCC Standards, input of users and other interested parties was sought and evaluated. Additional written inquires, comments, and suggested revisions should be submitted to the TMDD Coordinator, at the above address, in the following form:

Document Name:
Version Number:
Section Number:
Paragraph:

Comment:

Please include your name, address, organization and contact information in your correspondence.

Additional material and procedures regarding requesting updates and revisions are given in Section 12 of this Guide.

In addition, there are a small number of documents associated with the TMDD and MS/ETMCC Standards, which consist of the actual Standards themselves, and this Guide.

2 OVERVIEW OF THE TMDD & MS/ETMCC STANDARDS

This Section of the Guide is intended principally for decision makers and managers such as a City Traffic Engineer or a Traffic Operations Engineer in charge of a regional or district office of a State transportation department, as well as the staff that serve them. This Section provides an overview of the TMDD & MS/ETMCC Standards, motivations behind their use, the need for the Standards, as well as their key features.

2.1 Introduction

Historically, transportation professionals and system integrators have used proprietary or unique definitions of transportation data to build their own applications and implementations. Data described in a proprietary or native fashion and subsequent messages constructed using such proprietary data have (1) restricted interoperability between various systems and (2) lessened the ability to exchange information among organizations and/or jurisdictions. For example, a message constructed using a definition of a roadway "Link Node" by one Traffic Management Center may not coincide with the definition of the same link node used by the Emergency Management Center in the same jurisdiction. In that example, ambiguity would be introduced in the basic message formation due to dissimilar data element definitions of the two agencies hindering interoperability and being contrary to the intent of the National ITS Architecture.

To facilitate the efficient, unambiguous, exchange of information in a manner that delivers desired ITS interoperability the Standards Development Organizations standardized the data elements, messages, and message sets using standards-based formats and templates. It was agreed that a Traffic Management Data Dictionary would contain data elements associated with the functional area of traffic management, from which messages can be constructed. As a result of this agreement, the TMDD Steering Committee was formed and has undertaken the two following related standards development efforts:

- ***Traffic Management Data Dictionary (TMDD):*** This Standard contains common data definitions called, *data elements*, which are used to transfer data between centers, for example roadway speed information being sent to an Information Service Provider. The Standard is organized in four separate sections and provides specific definition of selected data element currently in use and that are frequently needed to construct messages used by the ATMS applications. At present four sections have been developed into the following partitions:

    - Traffic Links and Nodes – the traffic network,
    - Events, Incidents and Notification Alarms – events perturbing the network,
    - Traffic Network, Traffic Signal Control, Traffic Detectors, Vehicle Probes, Ramp Metering, and Traffic Modeling – the traffic control devices, and
    - Closed Circuit Television, Dynamic Message Sign, Environmental Sensor Station, Gate, Highway Advisory Radio, and Parking – advanced information gathering or display devices

- ***Message Sets for External Traffic Management Center Communications (MS/ETMCC):*** This Standard contains common groupings of data organized into message sets for use in exchanging information between centers. It is a parallel standard to the TMDD Standard and focuses on the "traffic management" application messages used traditionally by transportation engineers. These messages are grouped based on the application needs and are organized to provide uniform information and interpretation throughout ITS deployment, both within the native system environment and with the external transportation management centers communications. The MS/ETMCC standard contains six message groups:

    - Roadway-Network,
    - Network-State,
    - Network-Events,
    - Traffic-Requests,
    - Traffic-Device-Status, and
    - Traffic-Control.

    These message sets provide for a near real-time data exchange between traffic management centers/ subsystems and the following types of transportation centers/ subsystems:

    - Information Service Providers (ISPs),
    - Transit Management,
    - Emergency Management,
    - Toll Administration, and
    - Emissions Management.

    Together the standards enable the effective exchange of data and information that are becoming increasingly necessary for system operations and management as recurring congestions levels and the pervasiveness of the effects of major incidents spread over larger areas.

Exhibit 2.1.1 illustrates a simple example of the basic relationships between data elements of the TMDD Standard and the MS/ETMCC Standard. Traffic Management Center 1 is represented by the set of boxes on the left side of Exhibit 2.1.1 while the boxes on the right side of the Exhibit represent Emergency Management Center 2. The TMDD & MS/ETMCC Standards are shown as previously being used by each of the centers in setting-up their internal database systems. Both Standards are indirectly used by Center 1 to send messages to Center 2. Both Standards are also indirectly used by Center 2 to receive and interpret the messages sent from Center 1.

Exhibit 2.1.1 shows that the TMDD Standards by themselves are necessary but not sufficient. The MS/ETMCC Standards are needed for the communication to occur in an interoperable fashion. Just using MS/ETMCC Standard may result in some communication but the content may not be understood at all without the TMDD Standard.

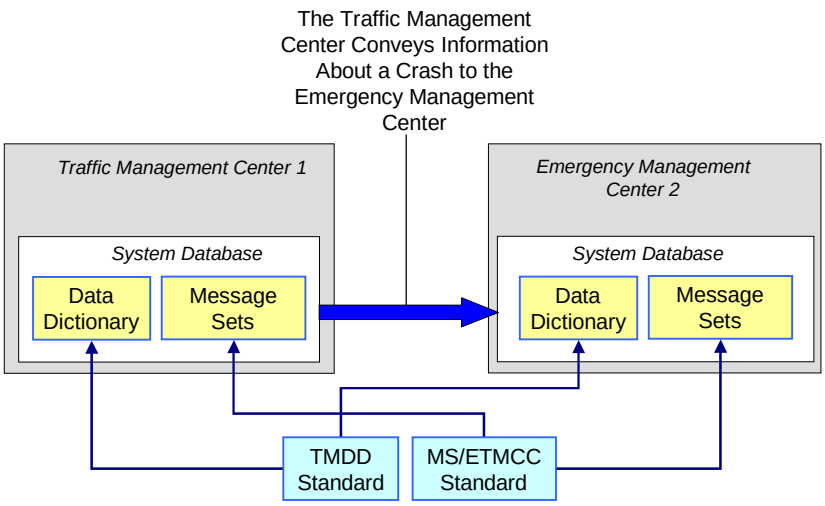

Exhibit 2.1.1: An Example Using Data Elements & Message Sets

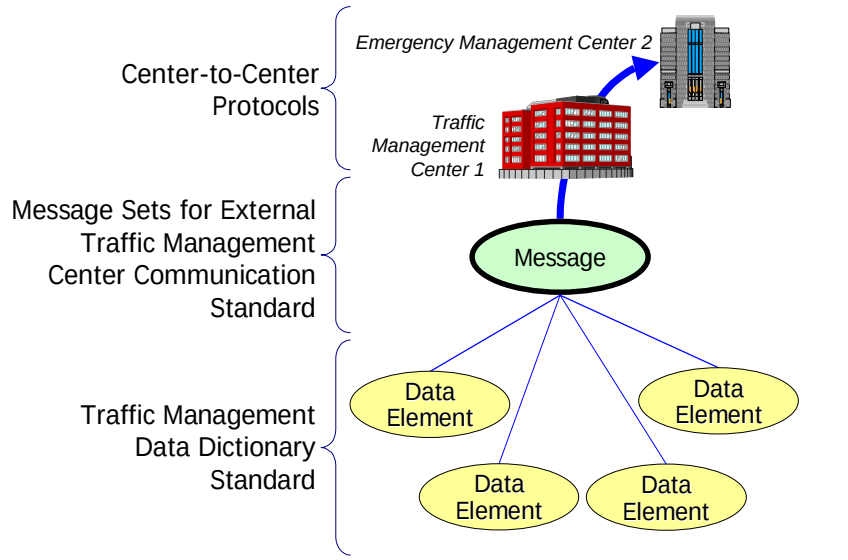

Exhibit 2.1.2: Functional Representation of the Example

Exhibit 2.1.2 shows the example from a functional perspective where a significant incident has just occurred and was detected by field devices of Traffic Management Center 1 who: (1) selects appropriate data elements describing the incident, (2) constructs one or more messages about the incident, and (3) transmits the message(s) to Emergency Management Center 2 using a center-to-center communication protocol. The message(s) then makes Emergency Management Center 2 aware of the incident and the information that Center 1 has about it. Center 2 would then use that information to carry out emergency responses that they deem appropriate.

2.2 What are the Functional Level TMDD & MS/ETMCC Standards?

ITE/AASHTO have jointly approved the following two related standards developed by the TMDD Steering Committee:

- ***TM 1.03, Functional Level Traffic Management Data Dictionary (TMDD)*** Standard is a set of agreed upon definitions and ways of formatting data for use by ITS systems that have the function of traffic management.

- ***TM 2.01, Message Sets for External Traffic Management Center Communications (MS/ETMCC)*** provides consistent ways for electronic communication messages to be exchanged among Traffic Management Centers, Traffic Management Systems, and other users and/or suppliers of traffic-related information.

These two Standards are built upon a data element format or base Standard 1489 issued by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE 1489 Standard is also deployed by other Standards Development Organizations to develop their own standards-based data dictionaries for Intelligent Transportation Systems. For example, the Society of Automotive Engineers (SAE) is developing an Advanced Traveler Information Systems (ATIS) Data Dictionary. Minor revisions for the TMDD Standard are underway to have the TMDD Standard fully conform to the 1999 revisions of the IEEE 1489 Standard.

2.3 Why Do We Need the TMDD & MS/ETMCC Standards?

Transportation professionals increasingly rely on the use of Advanced Traffic Management Systems (ATMS) to carry out their management and operational responsibilities of providing for safe and efficient operation of traffic on the roadway network. Systems implemented using TMDD & MS/ETMCC Standards can facilitate coordination of ATMS functions and provide information exchanges that help in meeting their responsibilities. In particular, the TMDD & MS/ETMCC Standards can help with the following situations:

- **Regional Interoperability of Traffic Management:** It is often said that the end users of transportation, the network-traveler or driver does not care or recognize what agency in a region is responsible for providing smooth and effective traffic management functions – they just want whoever is in charge to make it work well. It is therefore necessary for jurisdictions to coordinate their services across boundaries. For example, two adjacent states can exchange data and traffic information about an Interstate Highway passing through their region in an unambiguous manner because the data elements and message sets used to convey pertinent information are standards-based.

- **Local Interoperability of Traffic Management:** Within many jurisdictions different agencies usually provide various transportation functions and services**.**

Whether it is a traffic control function, transit services, or incident management a state, county, or city transportation agency may have jurisdiction for part of the overall transportation system and they need to coordinate their services for each specific local area. For example, a local City TMC that has jurisdiction for traffic signal control and incident management services may have to quickly convey information about a specific incident on one of their roadways in real-time (1) to a Transit Operation Center regarding bus signal priority control status, as well as (2) to coordinate with the regional TMC operated by the state managing the adjacent freeway. In such a case, the TMDD and MS/ETMCC Standards make local interoperability possible for traffic control, transit management, and freeway management systems.

- **Incident Management:** Many jurisdictions across the country have recognized the benefits resulting from the deployment of the ITS devices to detect, clear and mange incidents on their roadways. They have implemented incident management programs that bring state and local police, fire, Emergency Management Services, and Transportation Operation Center personnel together to coordinate efforts in their jurisdictions. In this instance the Incident Management message sets follow ones developed by the IEEE P1512 Standard, with input from the other public sector participants. That Standard addresses the inter-agency communication needs for emergency management functions organized in terms of messages. The TMDD and MS/ETMCC Standards have been harmonized with those Incident Management Standards.

- **Traveler Information Coordination:** In recent years, travel information systems are being deployed across the country in close coordination with public sector detector and incident data and other real-time data collected by traveler information service providers. Systems and databases deployed by many agencies and organizations must be harmonized using standards-based data descriptions so that travelers receive the information, which is based on the uniform interpretation by all developers and service providers. The TMDD & MS/ETMCC standards are being coordinated with the similar data dictionaries and message sets for Advanced Traveler Information Systems. That will enable the traveler information systems to make more effective use of the data already collected for traffic management purposes.

- **Life-Cycle Cost Considerations:** Use of the TMDD & MS/ETMCC Standards will make it easier, more efficient and effective, for Traffic Engineers, Traffic Operations Engineers, and managers of Traffic Management Centers to carry out their responsibilities. In the short-run, the effort to incorporate these Standards may require some up-front investment. However, over time there will be longer-term cost reductions because data transfer interfaces will not have to be customized. The expectation, from a life-cycle costs perspective, is that early adoption and use of the TMDD and MS/ETMCC Standards will result in less overall costs as well as more effective communications and improved service among Traffic Management Centers.

2.4 How will the Standards be Used in Overall System Implementaion?

Local communities, cities, counties, and states have for decades been making investments in providing traffic control and more recently traffic management and transit management systems. The main purposes behind having such systems are to provide for the safe and efficient management of traffic and transit on arterial and freeway networks. The cumulative investment in such systems can be substantial. However, from time-to-time, wholesale replacement or incremental upgrading of various parts or of the overall traffic management system is needed. This is often necessary for two main reasons:

- Component parts and equipment in the centers can begin to operate less reliably and need to be replaced due to the wear and tear of their constant or heavy use, and

- Other times such hardware and software begin to become functionally obsolete as the rapid pace of improved technologies and more powerful and more cost effective control systems become available.

The decision makers and managers who review and approve such initiatives should also be sure that allowance for the use of the TMDD and MS/ETMCC Standards is included in the needs and requirements for the system upgrade or replacement. The Standards should be appropriately referenced in specifying the traffic management system improvements. The actual process of design should also account for the Standards.

A particular concern to be addressed as part of the implementation process is the need to provide for migration alternatives to transition between various legacy systems and a system that is in full conformance with the Standards. The TMDD Standard provides flexibility for local variations that can help in such transitions or migrations between systems. Such transitions can also be eased by the development of an application-specific data dictionary.

2.5 When are Standard Data Dictionaries and Message Sets Useful?

The discussion above outlined conditions for which the TMDD & MS/ETMCC Standards can be useful in helping to meet the responsibilities of the traffic and operations staff, particularly whenever they need to communicate from one center to another center. Those responsibilities include addressing the repetitive periodic daily, weekly, seasonal, and annual cycles of changing demand and periodic changes in system supply, such as reversible arterial lanes or freeway High Occupancy Vehicle lanes and busways. The TMDD & MS/ETMCC Standards contain many data elements and message sets that are useful in characterizing and communicating information about recurrent congestion conditions.

However, the responsibilities also include the monitoring and management of conditions associated with sporadic incidents and planned non-recurrent special events. Those incidents and events can also affect the demand for and/or supply of transportation, whenever such incidents and events occur. The MS/ETMCC Standard in particular is more oriented towards

message sets that can be used in Incident Management. The Standards are also useful in characterizing the nature and effects of the incident so that messages can be communicated clearly, unambiguously, and quickly to groups such as incident management personnel or providers of traveler information. In the management of incidents, quick, effective communication is of paramount importance and can directly lead to the saving of lives, injury reduction, and the lessening of economic losses.

2.6 Who are the Expected Users of the TMDD & MS/ETMCC Standards?

The TMDD & MS/ETMCC Standards should be used by transportation, traffic, operations, and systems engineers who are involved with the development and management of traffic management systems. System software designers and application developers would also be typical users of the Standards.

The Standards can provide a way for staff, consultants, contractors and specialists to better communicate among themselves in the development and operation of traffic management systems. However, many of the actual TMC operating staff might never directly use the TMDD data elements in their daily activities. Rather, they would use an application-specific data element, in which the software translates into the proper functional data element. The range of typical responsibilities carried out by these staff include the following:

- Planning and program budgeting
- Design
- Specification
- Selection and procurement
- Installation, and
- Operation and maintenance of traffic management systems.

There are other direct and/or indirect users of the TMDD & MS/ETMCC Standards. Among them are the many different Public Safety, Police, Emergency Management System and Emergency Medical System groups who respond to incidents. These groups tend not to have standards like the TMDD or MS/ETMCC in operating their Computer Aided Dispatch systems. As such it can be expected that the TMDD & MS/ETMCC Standards may help increase their ability to developed more integrated emergency operations. The designers, developers, and operators of their systems will be increasingly interdependent with the ways in which items such as the location, nature, progress of managing, the effects, and records associated with incidents are defined and communicated. The TMDD & MS/ETMCC Standards can help foster increased interoperability of subsystems among all of the many groups involved with incident response and management.

Another group of indirect users will be the public agencies and private companies involved with various aspects of Advanced Traveler Information Systems. There will be interdependencies with (1) data and information needed in designing and operating such systems and services, and (2) the information they may be producing, such as short-term forecasts of likely future traffic

conditions. The latter would be useful information for traffic management centers to have in carrying out their real-time operations and management responsibilities.

2.7 What Lessons have been Learned from the Use of the Standards?

These Standards are recently devised and adopted by the Standards Development Organizations. Very few TMCs have deployed the Standards into their systems. However, several deployments are underway across the country that will utilize these Traffic Management Information Standards. As a result there so far is little experience with implementing and using the TMDD & MS/ETMCC Standards upon which to draw a set of lessons learned. This sub-Section is here mainly as a placeholder that can be expanded in a later version of this Guide.

One lesson being learned from the limited initial experiences is referred to in sub-Section 2.4 above. That concerns the need to provide for a plan or way to migrate and transition between various legacy systems and the system that is being designed in accordance with the Standards. Further discussion about this need is given in Section 5.4 of this Guide.

2.8 Where to go for Further Information or Training on these and Other Standards?

There are several ways in which an interested person can get additional information, and soon training, about these two Standards. These include the following:

- A person can of course first refer to the Standards themselves. There is explanatory material prepared as part of the standards.

- ITE and AASHTO maintain web sites, which contain background information on the two Standards. The web sites can be found by starting respectively at: (www.ite.org) and (www.aashto.org). In addition, staff of the two organizations can be contacted at the addresses given on the cover.

- Both of the sponsoring organizations, in conjunction with other Standards Development Organizations and the United States Department of Transportation (U.S. DOT) are planning a series of training opportunities for these two and other standards, starting in Fall 2000. Please consult either of the two web sites mentioned above or that of the U.S. DOT at (www.its.dot.gov/standard/standard.htm). The address and telephone for the appropriate office in U.S. DOT are as follows:

  Federal Highway Administration
  ITS Joint Program Office, Room 3422, HOIT-1
  400 7th Street, S.W.
  Washington, D.C. 20590

  Phone: 202-366-2180
  Fax: 202-493-2027

